industry less RBOCs), calculated from statistics on lines and switches reported to the FCC for 1993.

- Medium switch: the cost per line ($104 for 1994) was taken from the Northern Business Information report on the average cost of *new* lines for RBOCs. Hatfield associated the average *installed* switch size of 11,200 for RBOCs, calculated from statistics on lines and switches reported to the FCC for 1993.

- Large switch: cost per line of $75 for a 80,000 line switch, "obtained from switch manufacturers."

Hatfield then drew straight lines between the three points to determine a relationship between switch price and switch size.

Hatfield's approach suffers from two problems. First, there is a mismatch between the data sources he employs. Note, for example, he matches a 1994 forecasted price with a 1993 average embedded switch size. In addition, while Hatfield uses independents (excluding GTE) for the small switch price, GTE is included in the calculation of the switch size. Finally, the approach assumes that the *average* installed switch is of the same size as the average *new* switch, an assumption that is not necessarily valid.

Second, and more fundamental, the Hatfield model ignores the fact that LECs buy additional lines for installed switches as well as new lines for new switches. These additional lines cost more, as the study that Hatfield used for his switch prices describes.

The add-on market continues to retain revenue potential for the suppliers, particularly as the margins on new switches remain below the margins for the add-on market. A digital line shipped and in place will generate hundreds of dollars in add-on software and hardware revenue during the life of the switch. Suppliers can afford to lose a few dollars on the initial line sale in exchange for the increased revenue in the aftermarket, when prices are less likely to be set by competitive bidding.[19]

[19] Northern Business Information, *US Central Office Equipment Market—1994*, McGraw-Hill, p. 71.

The local switching component of the Hatfield model graphically illustrates the fallacy of its scorched view of cost studies. In order for the approach to produce realistic costs (ignoring the data problems identified earlier), a new entrant would have to serve customers with initial lines only and also have the volumes to command the discounts that existing LECs apparently command. The fact that LECs expand their switches as demand grows and the existence of a lucrative aftermarket for this expansion demonstrate that the "instant LECs" posited by the Hatfield model are inconsistent with reality.

The documentation for Release 1 describes a single number for end-office switching: investment per line. Yet, the model produces two cost estimate: ports and usage. It appears that the model assigns exactly 30 percent of end office switching costs to ports and the remaining 70 percent to usage. The resulting costs are then divided by external estimates of the number of lines and minutes served by end offices in a service territory. We are aware of no justification for the assignment of end office costs to lines and usage.

C. Converting Investments to Annual and Monthly Costs

The various manifestations of the Hatfield model are essentially models of the *investment* component of an LEC's cost structure. These investments are converted into annual and monthly amounts by (1) annualizing the investments through the use of cost-of-capital and depreciation rates and (2) estimating out-of-pocket operating expenses through the use of historical expense to investment ratios.

1. The Hatfield Model Underestimates the Cost of Capital

The 10 percent return in Release 2, although higher than that used in the earlier release, is too low for two reasons. First, the FCC's approved rate of return remains at 11.25 percent. Second, the whole premise behind Hatfield's cost estimates is that they emulate the effects of competition. One of these effects is to raise the riskiness, and therefore the cost of capital, of competing firms (incumbents as well as entrants). This, in turn, increases the annual capital cost for local exchange services.

2. The Hatfield Model's Depreciation Rates Are Lower Than Economic Depreciation

The Hatfield model uses long depreciation rates in estimating the annual costs of network investments. While such long investment lives may have been appropriate for a regulated monopoly provider, the competitive environment fostered by the Telecommunications Act is a different world. The forces of competition itself, as well as the technological change that permeates this industry, invalidate the use of the old long depreciation lives. In fact, Professor Hausman's May 30, 1996 reply affidavit demonstrates that accounting for the increased risk and uncertainty of competition increases the annual cost related to investments by a multiple of at least 3.

Release 2 of Version 2.2 of the Hatfield model lists asset lives by type of facility, e.g., end office switches have a life of 14.3 years in the model. In order to compare these depreciation lives with external sources, we have calculated a weighted (by monthly cost) of about 17 years, which is equivalent to an annual depreciation rate of 5.9 percent. This rate is somewhat lower than the 1994 book depreciation of 7.16 percent for RBOCs, let alone the higher true economic depreciation rate.[20]

Of course economic depreciation rates are much higher. For example, Schmalensee and Rohlfs reported that AT&T's depreciation rate is 18.5 percent.[21] Even AT&T's 1994 book depreciation rate of about 11 percent is much higher than the rates used in the Hatfield model.

3. The Operating Expense Estimates in the Hatfield Report Are Questionable

The Hatfield Report develops expense estimates based upon ratios of *booked* expenses to investment. This approach is problematic. Operating expense ratios based on historical investment may be a poor approximation of the forward-looking relationship. Consider, for

[20] Federal Communications Commission, Statistics of Communications Common Carriers, 1995/1995 Edition, Table 2.9.

[21] Richard Schmalensee and Jeffrey H. Rohlfs, "Productivity Gains Resulting From Interstate Price Caps for AT&T," National Economic Research Associates, September 1992.

example, an expense whose costs are unrelated to the underlying technology. As capital equipment becomes more (or less) productive, the expense to capital ratio changes, even though the absolute level of unit expenses does not.

The central office switching example discussed earlier illustrates the pitfalls of using annual factors. By employing the unrealistic assumption that an LEC can buy switching at the initial prices, the model assumes that annual cost (which we understand include the generic upgrades) would be lower as well. In fact, the very report that Hatfield relies on to develop the switch model suggests that such additional costs may increase when switch vendors discount initial prices.

The factor approach also suffers from the general problem that any decrease in an investment will cause a proportionate decrease in expenses. For example, if one LEC, for whatever reason, obtained a higher discount on its equipment, the model implies that it would enjoy lower out-of-pocket expenses, an implication that defies common sense.

V. COMPARISONS WITH EXTERNAL SOURCES

Version 2.2 of the Hatfield model produces estimates of network element costs, based on the abstract representations of network service costs. In contrast, the LECs have information on their current forward-looking costs of doing business. Because the prices for unbundled network elements obtained from the LECs must at least recover their costs, such a comparison is extremely informative.

Pacific Bell has provided the California Public Utilities Commission with results from its Cost Proxy Model (CPM) in the context of universal service.[22] Based upon our participation in the California unbundling and universal service proceedings, we understand that the CPM is designed to replicate the forward looking costs of Pacific's operations, because the model represents the engineering rules and cost-of-equipment Pacific actually uses.

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[22] Pacific Bell and INDETEC International, The Cost Proxy Model, California Universal Service Subsidy, 1996.

To compare the output of the two models, we calculate the monthly cost for loops and local switching , which are common to both models. The results are $14.24 and $23.12 for the Hatfield model and the CPM, respectively. In short, the Hatfield model produces costs that are about 62 percent as high as Pacific's.[23] In light of the various shortcomings we discussed previously which would tend to understate the costs produced by the Hatfield model, the CPM's results are clearly the more plausible.

VI. INTERNAL CONSISTENCY

A. The Hatfield Model Is Not A Valid Cost Model

The Hatfield model is not a valid economic cost model because it fails the internal and external consistency checks required of any cost model. This is more than just a theoretical point. Failure to satisfy these checks means that the Hatfield cannot represent the minimum cost of producing outputs using the most efficient forward looking technology. In Attachment I, we show this and also show that any numbers the Hatfield model produces purporting to be TS/TELRICs are biased in an unknown direction. This makes them useless for even the minimal task of providing upper and or lower bounds for prices. Further, we will show that the underlying approach is so flawed as to render the Hatfield model impossible to fix without a complete overhaul, starting with the basic conceptual approach and ending with data requirements.

B. Cost models and TS/TELRIC calculations

The primary purpose of a cost model is to answer the question "What is the minimum cost of producing a stream of outputs using the most efficient forward looking technology and

[23] The loop costs produced by Release 2 of the Hatfield model are 25 percent higher than those produced by Release 1. In contrast, in Texas, loop costs increased by only about one percent between releases. In both states, locals switching costs hardly changed.

facing a perhaps uncertain stream of input prices?" To use a cost model to calculate a TS/TELRIC for a product, one calculates the minimum cost of doing business as usual and subtracts from that the minimum cost of doing business if a product line were dropped from production. Both components of this difference should be dynamic cost functions, not costs calculated only for the year in question, but costs calculated over the optimal planning horizon of the firm. Single period static cost functions are totally inappropriate.

C. Valid cost models

A valid cost model shows the relationship between the minimum cost of producing a flow of services using the most efficient technology, given a set of expected input prices, starting today and flowing into the future as far as the firm's optimal planning horizon. Specifically, for input prices and output levels in each year of the planning period, it shows the minimum present discounted value of producing those levels of outputs.

As a consequence of this minimization, costs functions and cost models necessarily satisfy a set of mathematical properties which can be found in a first year graduate textbook such as 'Microeconomic Analysis' by Hal Varian. Rather than a complete listing of them, we will discuss two that the Hatfield model clearly violates. The first is linear homogeneity in prices; this means if all prices are increased proportionately, then total costs will increase by the same proportion. The second is the derivative property. An easily understood form of the derivative property is this: the percentage increase in total costs as a consequence of a one percent increase in the price of an input, i.e., labor , loops, wire, and the like, will be exactly equal to the share of total costs directly attributable to that input. So if cable of a certain grade comprises 10% of total costs and its price rises 100%, then total costs should rise 10% as a consequence.

To test the linear homogeneity assumption we increased all the input prices in the Hatfield model by 10% using their default California data as a base case. A valid cost structure should yield an increase in TS/TELRICs of 10% as well[24]. The results can be seen in Table 2, and can be seen to yield increases of roughly 13%—a number 30% higher than it should be.

Table 2:Comparison of Hatfield TSLRIC Results
California

	Base	Costs with Prices Increased 10%, Including Capital Costs	Percent Change	Percent of Tot Cost of Netwo Elements (Bas
Loop Distribution	$5.8896520	$6.6889909	13.5719%	38.9
Loop Concentrator/Multiplexer	$1.9731690	$2.2106022	12.0331%	13.0
Loop Feeder	$2.4756549	$2.8369102	14.5923%	16.3
Local Switching	$1.1665027	$1.3116290	12.4411%	21.6
Other				9.9
Operator Systems	$20,717,935	$22,797,842	10.0392%	
Common Transport	$0.0008782	$0.0009917	12.9209%	
Dedicated Transport	$4.9076776	$5.5374631	12.8327%	
Signaling Link Transport	$18.7658876	$21.0823047	12.3438%	
Signaling Transfer Points	$0.0000316	$0.0000355	12.3438%	
Service Control Points	$0.0010527	$0.0011827	12.3438%	
Tandem Switching	$0.0009939	$0.0011189	12.5737%	
Total Cost of Network Elements	$3,342,085,225	$3,783,217,721	13.1993%	

In the attachment we show that to the extent the Hatfield Model maintained the multiplicative structure of its past versions one should expect the derivative property of cost functions to be violated as well. Regardless of the source or reason for the error, the fact that the model produces wrong results is incontrovertible. And to emphasize the consequences of the error we once again point out that any cost function or cost model that fails even one of the

[24] This result is proved in Attachment I.

criteria required of a cost function, whether as stated above or found in a text, cannot represent the minimum cost of producing services using the most efficient forward looking technology.

VII. THE HATFIELD MODEL IS BASED ON INAPPROPRIATE STATIC NOTIONS

Because the Hatfield model is a static rather than a dynamic model, it mishandles growth and underestimates the true forward-looking cost of capital. It totally ignores growth and in doing so, it mischaracterizes that spare capacity which results from optimal timing of laying discrete plant, instead labeling it as inefficient over-capacity. A consequence of this is Hatfield's concentration on and insistence that fill factors are too low. In fact, at least since the mid 1970's it has been well known that in a dynamic context, the problem of optimally investing in discrete plant when there is growth has a component not found in static situations. In his 1978 paper in the *Review of Economic Studies*, David Starret shows that the cost minimizing firm in a dynamic situation trades off some spare capacity against the economies of scale in construction. The firm cost minimizes by choosing the lengths of the intervals between which it invests. During periods between investments there will always be spare capacity and it is often optimal and cost minimizing to always have spare capacity. Moreover, the mathematical structures that might be appropriate in a static situation may not be in the dynamic one. To determine whether or not they are appropriate requires the kind of empirical testing that the Hatfield model has not undergone.

Second, it underestimates real cost of capital by ignoring the effects on the cost of capital that attend (a) the increased riskiness of an industry moving rapidly into competition and (b) the increased economic depreciation rates required recover investment in current plant and equipment. Failure to recover sunk investment has severe economic consequences; for the rate and level of the recovery of capital not only tell firms which activities to direct the use of their existing equipment but also dictate whether or not there is an incentive to replace equipment, as it becomes obsolescent, with the next generation. Indeed, by ignoring dynamics altogether, it fails to be forward looking even in concept.

VIII. Concluding Remarks

There are many reasons not to use the Hatfield model to determine TS/TELRICs and none to support its use. Primary among these is that it has never been tested against real data as might be expected of any model of any type. Trying to use it in spite of this is a little like asking paying customers to fly on a plane the type of which has never before flown or even tested. As an added insight to the problem of using a model that it has not been verified on actual data consider the following example. Suppose that the IRS decides to simplify its analysis of all of the paper work associated with reporting and verifying tax payers' income. To make the process easier, the IRS decides to create a model that estimates how much income from employment and investment a person makes each year. The model is simply based on assumptions about how much a person should be making based on the tax payer's age and the number of years of schooling that the person has completed. To use this model, the IRS enters the person's age and number of years of schooling and lets the model derive an estimate of income which is used in place of any reported income. Despite valid criticisms of consumer groups and without taking the time to validate what the model predicts with actual income data, the IRS then uses this model to estimate a tax payer's income and taxes the person accordingly. We would hope everyone recognizes this as a ludicrous idea but this is an exact analogy of what the Hatfield model is doing to incumbent local exchange carriers.

Beyond lack of external verification and empirical validity, explicit economic and conceptual flaws were identified that make it unlikely the model could produce any useable numbers. The model is static rather than dynamic which gives rise to, among other things, fill factors that are too high. The model does not even satisfy the minimum criteria required of properly constructed cost models—that increasing all prices an common proportion must increase TS/TELRICs by exactly the same amount. In addition, are the other fundamental flaws in the Hatfield model that we identified (1) it models the cost of no realistic local service provider and certainly not the incumbent LECs who will actually sell the unbundled elements it attempts to cost and (2) particular inputs and processes appear to systematically understate the costs of network elements. Indeed, at the same time that AT&T reported to the FCC that it would cost $1,240 per customer if AT&T provided local service to 20 percent of the market (likely the least costly part of the market), it and MCI are supporting models that produce investment costs of only $840 per line.[25]

Like any model, the Hatfield model is best interpreted in the context of why it was built and what objectives it is intended to foster. The architects and sponsors of the Hatfield model are quite clear in their purpose—they want to buy elements from the LECs, most prominently switched access, at rates far below current rates and even below the costs of the LECs require to produce these elements. While we would all like to pay lower prices, markets only permit this when those prices are commensurate with the costs of production.

The Hatfield model developers defend their costs by arguing that any difference between the costs of their model and costs reported by the LECs (either accounting costs that are required by law and by regulators or the cost produced by LEC incremental cost models) represent the costs of overinvestment. For example, the report describing the "greenfield" version of the Hatfield model that was attached to MCI's opening comments claims that about half of the LEC's current plant represents overinvestment. Apart from the facts that this label is entirely circular and Hatfield's estimate of the so-called gap is fatally flawed by the theoretical and measurement problems with the Hatfield models, it defies common sense to believe that the overinvestment of this degree could take place.[26] Regulators (both at the federal and state level) would have to have been quite derelict in their public responsibilities in order for this event to have occurred, an unlikely event given the scrutiny this industry receives. Perhaps even more

[25] The FCC's April 19, 1996 Notice of Proposed Rulemaking listed the costs AT&T reported it would incur. The Hatfield investment per line is calculated from the "greenfield" version of the model.

[26] Some of the gap between book investment and forward looking investment could represent the effect of the decline in prices for facilities such as end office switches. The fact that current prices recover some of these costs is entirely consistent with the economic fact that with technological change, no firm could survive by charging prices that completely reflect the decline in new equipment prices.

telling, employees and representatives of the IXCs and other companies purchasing inputs from the LECs would have had to have been asleep at the switch to allow their companies to pay allegedly bloated prices for inputs for years without insisting on immediate correction of the situation. Of course, the more important concern is how network elements are unbundled in a way that promotes competition. Basing prices on costs that no real-world provider could hope to meet is *anti-competitive*, because it would stifle, not promote the most effective type of competition—facilities-based. In addition, requiring incumbent LECs to sell inputs at non-compensatory rates would have the deleterious effects of forcing whatever captive customers that may remain to subsidize the below-cost input prices and/or severely handicapping firms that represent a substantial proportion of this dynamic industry.

ATTACHMENT I:

In this Attachment we demonstrate that the Hatfield Model violates the derivative property and that it produces biased TS/TELRICs.

Let i=1,...,n index the types of cable, let p_{ci} be the price per foot of the ith type of cable, let L_{ci} be the miles of the ith type of cable, let E^{o}_{si} be the base year expense of structure and installation for cable of type i and let E^{o}_{ci} be the base year expense of cable of type i, let E_{si} be the cost minimizing expenditure for expenses associated with cable of type i and let E_{ci} be the cost minimizing expenditure on cable of type i, and let y be the output for which a TS/TELRIC is desired.

A. The Hatfield Model Violates the Derivative Property

The loop cost part of the Hatfield model may be represented as

$$C = \sum_{i=1}^{n}(p_{ci}L_{ci})\left[1+\left(\frac{E^{o}_{si}}{E^{o}_{ci}}\right)\right].$$

The derivative property of cost functions requires that the derivative of a cost function with respect to an input price give the optimal amount of the input.[27] Thus, the derivative of C with respect to p_{ci} should give L_{ci}. Symbolically this is,

$$\frac{\partial C}{\partial p_{ci}} = L_{ci}.$$

Unfortunately, direct calculation of the partial derivative of the Hatfield model yields

[27]We use the level form of the derivative property here rather than the proportional or logarithmic derivative form we used in the text, because the level form has easier mathematics.

$$\frac{\partial C}{\partial p_{ci}} = L_{ci}\left[1+\left(\frac{E^o_{si}}{E^o_{ci}}\right)\right]$$

which is an over statement of L_{ci} by a factor of

$$\left[1+\left(\frac{E^o_{si}}{E^o_{ci}}\right)\right].$$

B. Hatfield TS/TELRICs Are Biased

For simplicity, assume only expenditures on cable, and expenses. The results are exactly the same with switching and expenses except the notation is more elaborate and difficult to follow. The Hatfield Model gives a cost function of the following form:

$$\begin{aligned} C^* &= \sum_{i=1}^{n}(p_{ci}L_{ci})\left[1+\left(\frac{E^o_{si}}{E^o_{ci}}\right)\right] \\ &= \sum_{i=1}^{n}(E_{ci})\left[1+\left(\frac{E^o_{si}}{E^o_{ci}}\right)\right]. \end{aligned}$$

The cost minimizing cost function is

$$C = \sum_{i=1}^{n}(E_{ci} + E_{si}).$$

Use the difference calculus to obtain Hatfield TS/TELRIC and the true TS/TELRIC.

For the Hatfield Model,

$$\Delta C^* = \sum_{i=1}^{n}(\Delta E_{ci})\left[1+\left(\frac{E^o_{si}}{E^o_{ci}}\right)\right],$$

for the true model

$$\Delta C = \sum_{i=1}^{n} \left(\Delta E_{ci} + \Delta E_{si} \right).$$

Taking the difference between the terms gives

$$\Delta C - \Delta C^* = \sum_{i=1}^{n} \left(\Delta E_{ci} + \Delta E_{si} - \left(\Delta E_{ci} \right) \left[1 + \left(\frac{E_{si}^o}{E_{ci}^o} \right) \right] \right)$$
$$= \sum_{i=1}^{n} \left(\Delta E_{si} - \left(\Delta E_{ci} \right) \left(\frac{E_{si}^o}{E_{ci}^o} \right) \right)$$
$$= \sum_{i=1}^{n} E_{si}^o \left(\frac{\Delta E_{si}}{E_{si}^o} - \frac{\Delta E_{ci}}{E_{ci}^o} \right).$$

Dividing by Δy, multiplying and dividing by y and rearranging terms gives

$$\frac{\Delta C - \Delta C^*}{\Delta y} = \sum_{i=1}^{n} \frac{E_{si}^o}{y} \left(\frac{\Delta E_{si}}{E_{si}^o} \frac{y}{\Delta y} - \frac{\Delta E_{ci}}{E_{ci}^o} \frac{y}{\Delta y} \right)$$

which is the bias in the incremental costs. The bias is then a weighted sum of the differences between installation and structure expenditure elasticities and the cable expenditure elasticities.

C. Valid TS/TELRICs Must Be Linear Homogeneous in Input Prices

As discussed above, total cost functions must be first degree (or linear) homogeneous in input prices. This means if all input prices are increased by the same percent, say 10%, than total costs will increase by the same percent, in this case 10%. In this section we show that TS/TELRICs must satisfy the same requirements. We state the result as a Lemma

TS/TELRICs are linear homogeneous in input prices.

Proof:

Let the total cost of providing n services at levels $y_1, \ldots y_n$, with m inputs which have prices $w_1, \ldots, w_m$ be denoted $C(y_1, \ldots y_n, w_1, \ldots, w_m)$. The TS/TELRIC for service 1 is given by

$$\text{TS/TELRIC}_1(y_1,\ldots y_n,w_1,\ldots,w_m) = C(y_1,\ldots y_n,w_1,\ldots,w_m) - C(0,y_2,\ldots y_n,w_1,\ldots,w_m).$$

Where $C(0, y_2, \ldots y_n, w_1, \ldots, w_m)$ is the minimum cost of dropping the production of service one entirely while keeping the levels of all other outputs at their previous values. Thus, both $C(y_1,\ldots y_n, w_1,\ldots,w_m)$ and $C(0,y_2,\ldots y_n, w_1,\ldots,w_m)$ satisfy the linear homogeneity requirements,

$$\lambda C(y_1,\Lambda\ ,y_n,w_1,\Lambda\ ,w_m) = C(y_1,\Lambda\ ,y_n,\lambda w_1,\Lambda\ ,\lambda w_m)$$
$$\lambda C(0,y_2,\Lambda\ ,y_n,w_1,\Lambda\ ,w_m) = C(0,y_2,\Lambda\ ,y_n,\lambda w_1,\Lambda\ ,\lambda w_m)$$

Thus, by subtraction

$$\lambda C(y_1,\Lambda\ ,y_n,w_1,\Lambda\ ,w_m) - \lambda C(0,y_2,\Lambda\ ,y_n,w_1,\Lambda\ ,w_m)$$
$$= C(y_1,\Lambda\ ,y_n,\lambda w_1,\Lambda\ ,\lambda w_m) - C(0,y_2,\Lambda\ ,y_n,\lambda w_1,\Lambda\ ,\lambda w_m)$$

or

$$\lambda \text{TSLRIC}(y_1,\Lambda\ ,y_n,w_1,\Lambda\ ,w_m) = \text{TSLRIC}(y_1,\Lambda\ ,y_n,\lambda w_1,\Lambda\ ,\lambda w_m).$$

Which says, in words, that proportionally increasing all input prices will increase TS/TELRICs by the same proportion.

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Exhibit No:	
Issues:	Hatfield Model
Witness:	Tardiff
Type of Exhibit:	Rebuttal Testimony
Sponsoring Party:	Southwestern Bell Telephone Company
Case Nos.:	TO-97-40
	TO-97-67

SOUTHWESTERN BELL TELEPHONE COMPANY

CASE NOS. TO-97-40 & TO-97-67

REBUTTAL TESTIMONY

OF

TIMOTHY J. TARDIFF, PH.D.

St. Louis, Missouri

September 1996

CASE NOS. TO-97-40 & TO-97-67
SOUTHWESTERN BELL TELEPHONE COMPANY
REBUTTAL TESTIMONY OF TIMOTHY J. TARDIFF

I. INTRODUCTION AND SUMMARY

Q. PLEASE STATE YOUR NAME, OCCUPATION, AND BUSINESS ADDRESS.

A. My name is Timothy J. Tardiff. I am a Vice President at National Economic Research Associates, 1 Main Street, Cambridge, MA 02142.

Q. BRIEFLY SUMMARIZE YOUR QUALIFICATIONS AS THEY PERTAIN TO THIS TESTIMONY.

A. I received the B.S. degree from the California Institute of Technology in mathematics (with honors) in 1971 and the Ph.D. in Social Science from the University of California, Irvine in 1974. From 1974 to 1979, I was a member of the faculty at the University of California, Davis. I have specialized in telecommunications policy issues for about the last 14 years. My research has included studies of the demand for telephone services, such as local measured service and toll; analysis of the market potential for new telecommunications products and services; assessment of the growing competition for telecommunications services; and evaluation of regulatory frameworks consistent with the growing competitive trends. I have filed testimony and reports on behalf of Pacific Bell before the California Public Utilities Commission on incremental cost principles, rules for local competition, universal service funding, open access and network architecture, regulation of wireless telecommunications services, the treatment of accounting changes for post-retirement benefits under price caps, the review of California's price cap plan, and flexible pricing for Centrex service. I have also submitted reports on behalf of Pacific Bell before the Federal Communications Commission on price cap productivity, access to intelligent networks, interconnection pricing policies, and the treatment of accounting changes for post-retirement benefits under price caps. I have also testified for GTE North on intraLATA presubscription before the Illinois Commerce Commission, and filed a report with the New York Public Service Commission on intraLATA presubscription on behalf of New York Telephone. Exhibit 1 is a copy of my resume.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I am filing testimony in this proceeding on behalf of Southwestern Bell Telephone Company - Missouri ("SWBT-MO"). The purpose of my testimony is to appraise, from an economist's perspective, the conceptual validity and policy applicability of the Hatfield Cost Model, Version 2.2, Release 2 ("HCM 2.2.2" or "Hatfield model," or "Model") that has been submitted in this proceeding by AT&T Communications of the Southwest, Inc. ("AT&T").[1] In the process, I will assess the usefulness of the Model to the Missouri Public Service Commission ("PSC") for determining the total element long run incremental costs of, and rates for, various switched network elements offered on an unbundled basis by SWBT-MO.

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. HCM 2.2.2 is a proxy cost model that should not be used to establish the costs of, or prices for, unbundled network elements offered by SWBT-MO. Cost studies for that purpose should, more appropriately, be based on the forward-looking costs that SWBT-MO will encounter in operating its network consistent with the market circumstances it faces rather than on some purely hypothetical view of the network, both now and in the future. Moreover, since HCM 2.2.2 almost entirely disregards SWBT-MO's past, it succeeds only in approximating the costs that would likely be experienced by a mythical (not realistic) brand new start-up firm that is completely unconstrained by past network development and technology choices, but which is instantaneously able to serve the entire volume that SWBT-MO's network elements currently serve. This limitation of the Model severely restricts its value in setting policy goals and directions (and prices for unbundled network elements, in particular) for an *existing* network like SWBT-MO's.

Q. WHAT DO YOU MEAN BY A MYTHICAL NEW ENTRANT?

A. HCM 2.2.2 conjures up a hypothetical new network that is able to combine the hyper-efficiencies that such a network, built instantaneously to serve a known level of demand, would enjoy with the extremely low installation costs that would occur if all capacity could be

[1] Direct Testimony of Robert P. Flappan, AT&T Communications of the Southwest, Inc., September 16, 1996.

installed instantly on a "blank slate." Accordingly, the Model neither produces costs of an efficient entrant (which cannot expect to completely and instantaneously displace the incumbent) nor those of an incumbent like SWBT-MO even as it operates its network efficiently. Apart from this fundamental flaw in HCM 2.2.2's basic approach, particular input prices included in the Model are not consistent with the prices that telephone companies in Missouri actually face using efficient technologies and network configurations. It is an elementary proposition in economics (as well as simple common sense) that using the wrong input prices in a cost calculation produces incorrect estimates of the costs of network elements.

Q. WHAT WOULD BE THE CONSEQUENCE OF UNREALISTICALLY LOW ESTIMATES OF NETWORK ELEMENT COSTS?

A. Basing prices on costs that no real-world provider could hope to meet would be *anti-competitive* because it would stifle, not promote, the most effective form of competition, namely, facilities-based competition. Two types of distortions to competition would result. First, pricing unbundled elements below any reasonable estimate of cost would thwart efficient competition for local exchange service, contrary to the express intention of the Telecommunications Act of 1996. Second, non-compensatory prices for unbundled elements would undermine SWBT-MO's incentives to improve its network because an adequate return for its investment would not be forthcoming.

In addition, requiring incumbent local exchange carriers (LECs) to sell inputs at non-compensatory rates would have the deleterious effects of forcing whatever captive customers that may remain to subsidize the below-cost unbundled network element prices and/or of severely handicapping the incumbent facilities-based providers, which represent a substantial proportion of this dynamic industry.

II. ECONOMIC AND REGULATORY CONSIDERATIONS

Q. DOES THE HATFIELD MODEL CONFORM TO SOUND ECONOMIC PRINCIPLES?

A. No. The Hatfield model does not conform to sound economic principles on a number of counts. Most prominently, it fails to reflect the costs of a local exchange carrier (LEC) that is facing increasing competition as a result of technological advancement and regulatory developments. The Hatfield model documentation characterizes the Model as "scorched node," i.e., it starts with the existing locations of central offices and then builds a brand new network instantaneously from the ground up.[2] In other words, the Model puts in place all facilities to serve current demand levels without accounting for the growth dynamics that produce real networks. While proponents of this approach claim that it approximates the textbook definition of long-run cost, it is grossly at odds with how real businesses incur costs, especially capital-intensive firms that expand their facilities by adding capacity in discrete modules.[3] Almost five years ago, Professor Alfred Kahn (a former Chair of the New York Public Service Commission) advised the FCC of the need to employ a realistic and practical perspective.

> In strict economic terms, the concept of long-run marginal costs relates to a hypothetical situation in which *all* inputs are variable, and a supplier confronts the possibility of installing entirely new facilities, in effect from the ground up. And the "marginal" relates to the incremental cost of a single unit of output. The concept of long-run incremental cost, in contrast, is more pragmatic: it takes a firm's past history as given, does not assume that it is writing on a blank slate, but recognizes that it will ordinarily be planning the installation of new capacity, at whatever that additional investment will cost given its current situation, and it spreads the costs over either the total output of that additional capacity—in that sense it is a kind of average incremental cost—or over the additional output that is likely to be induced by a price reduction under consideration (or curtailed in response to a price increase.)[4]

[2] A number of long-run incremental cost studies performed by LECs have employed a different version of the "scorched node" assumption. For example, Pacific Bell and GTE have developed costs based upon consensus costing principles adopted by the California Public Utilities Commission. California Public Utilities Commission, Decision 95-12-016, December 6, 1995, Appendix C, at 4. The Hatfield model departs from the California principles in at least two significant ways: (1) Hatfield only uses the existing locations of central offices, while the California principles require that the existing location of outside plant be used as well and (2) by positing an "instantaneous" network, the Hatfield version of "scorched node" ignores the impact of changes in demand on cost.

[3] Even the theoretical definition must be conditioned by reality. For example, Professor Varian has noted: "Long run and short run are of course relative concepts. Which factors are considered variable and which are considered fixed depends on the particular problem being analyzed. You must consider over what time period you wish to analyze the firm's behavior and then ask what factors can the firm adjust during that time period." Hal R. Varian, *Microeconomic Analysis,* (3d ed. 1992), at 66.

[4] Affidavit of Alfred E. Kahn, (submitted to the FCC, CC Docket No. 91-141, August 6, 1991).

Q. DOES THE HATFIELD MODEL PROPERLY REPRESENT THE FACT THAT TELECOMMUNICATIONS CARRIERS ARE SUBJECT TO CONTINUOUS TECHNOLOGICAL CHANGE?

A. Absolutely not. In an industry with rapid technological progress, such as telecommunications, no company would set prices based upon costs determined by the Hatfield model. The reason is that as technology advances, basing prices on the Hatfield view of the world would never recover costs. Professor Kahn and I recently noted this phenomenon as follows:

> In a world of continuous technological progress, it would be irrational for firms constantly to update their facilities in order *completely* to incorporate today's lowest-cost technology, as though starting from scratch: investments made today, totally embodying *today's* most modern technology, would instantaneously be outdated tomorrow and, in consequence, never earn a return sufficient to justify the investments in the first place. For this reason, as Professor William J. Fellner pointed out many years ago, firms even in competitive industries would systematically practice what he calls "anticipatory retardation," adopting the most modern technology only when the progressively declining real costs had fallen sufficiently below currently prevailing prices as to offer them a reasonable expectation of earning a return on those investments over their entire economic life. In consequence even perfectly competitive prices would not be set at the level of these (totally) current costs—unless, to put it another way, the calculated costs of the new plant included an extremely high rate of return and of depreciation, in reflection of the exposure of any such investments to costs and prices progressively declining in real terms over their life.[5]

Q. AT&T STATES THAT THE HATFIELD MODEL "COMPLIES WITH THE DETAILED EXPLANATION OF THE COST METHODOLOGY ADOPTED BY THE FCC." [FLAPPAN AT 15] DOES THIS MEAN THAT THE FCC HAS SELECTED, OR SHOULD SELECT, THE HATFIELD MODEL FOR CALCULATING COSTS AND SETTING PRICES FOR UNBUNDLED NETWORK ELEMENTS.

A. Absolutely not. We have only AT&T's unsupported assertion that the Hatfield model complies with the FCC cost methodology. In my testimony, I show that the Model falls short

[5] Declaration of Alfred E. Kahn and Timothy J. Tardiff, (submitted to the FCC, CC Docket No. 96-98, May 30, 1996) (footnote omitted). Professor Jerry Hausman's reply affidavit, filed in this docket on the same day, makes a similar point in the context of depreciation.

in many important respects, and that neither the PSC nor the FCC should consider adopting it in its present state. Moreover, the FCC has merely recognized that the Hatfield model is one among a number of models that could be considered as a candidate for determining proxy costs. That does *not* imply that the FCC has made its choice or has endorsed the Hatfield model as it presently exists.

Q. AT&T CITES THE EXAMPLE OF THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION AS APPARENT PROOF OF ACCEPTANCE OF THE MODEL AMONG REGULATORS. [FLAPPAN AT 15] SHOULD THAT BE REASON ENOUGH FOR THE MISSOURI PSC TO ADOPT THE MODEL AS WELL?

A. No. Each regulatory agency (like the Missouri PSC or the FCC) will have the opportunity to determine independently whether or not, on the basis of the evidence presented, the Hatfield model should be selected for the purpose of determining the costs of, and prices for, unbundled network elements. Obviously, the PSC will weigh the evidence put forward by the various parties, taking notice of actions in other jurisdictions as appropriate. Of course, circumstances differ between jurisdictions, so that rulings of regulators in those jurisdictions will differ accordingly.

Q. AT&T CLAIMS THAT THE "HATFIELD MODEL COSTS ARE THE CURRENT BEST EVIDENCE THAT THE MISSOURI PSC HAS UPON WHICH TO BASE PRICES FOR UNBUNDLED ELEMENTS." [FLAPPAN AT 5] DO YOU AGREE?

A. Certainly not. AT&T's exaggerated claims about the quality of the Hatfield model costs notwithstanding, I believe the PSC has not yet had the opportunity to view all the evidence from all interested parties. In particular, results from SWBT-MO's own study of the relevant costs will undoubtedly prove to be very helpful to the PSC. About the only thing that can be said at this point about the Hatfield model results is that they present *one* set of candidate proxy costs for the PSC to consider. As I show in my testimony, these costs are of dubious value at best.

III. THE HATFIELD MODEL: DESCRIPTION AND EVALUATION

Q. WHAT IS HCM 2.2.2?

A. HCM 2.2.2 is the Hatfield Cost Model, Version 2.2, Release 2, prepared by Hatfield Associates, Inc., of Boulder, Colorado, on behalf of its sponsors, AT&T Corporation and MCI Telecommunications Corporation. In its present form, HCM 2.2.2 is an engineering model that purports to construct the total element long run incremental costs of switched network components (e.g., loop facilities, switching, signaling, transport facilities, etc.).

Q. WHAT IS TOTAL ELEMENT LONG RUN INCREMENTAL COST?

A. An incremental cost is the cost incurred by a firm to produce the next increment of output. When the increment of output is the entire quantity of a network element, that cost is called a total element incremental cost. When the cost is measured in the long run (i.e., a period of time long enough for the firm to vary or adjust its factors of production for supplying additional units of the element), it is called a total element long run incremental cost, or TELRIC. TELRIC may be measured as the difference between (1) the total cost of a firm's current outputs (including the element for which TELRIC is being measured) and (2) the total cost of the firm if it produced all but the element in question. The background assumption is that these costs are always measured when using forward-looking and efficient technology and following cost-minimizing practices. The TELRIC includes only the *directly* attributable part of an element's economic cost. In addition, a suitable portion of common (overhead) and/or shared fixed costs of the firm must be included in the prices of unbundled elements.

Q. IS THE HATFIELD MODEL COMPLETE AT THIS TIME?

A. No. The Model appears to be undergoing continuous change. In particular, the estimated costs for unbundled network elements presented in this proceeding are different from the results submitted to the FCC in May of this year, because the model has changed substantially to the point of completely new software being released. The new version, HCM 2.2.2, has supposedly retained the structure of the earlier HCM 2.2.1 (Release 1) but modified a number of the assumptions and inputs embedded in it. A number of these changes would tend to